NON-PUBLIC?: N
ACCESSION #: 9406210369
LICENSEE EVENT REPORT (LER)

FACILITY NAME: HOPE CREEK GENERATING STATION PAGE: 1 OF 6

DOCKET NUMBER: 05000354

TITLE: Engineered Safety Feature Actuation - Reactor scram on
low level due to design and training deficiencies.
EVENT DATE: 05/15/94 LER #: 94-007-00 REPORT DATE: 06/14/94

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 096

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: Louis Aversa, Senior Staff Engineer - TELEPHONE: (609) 339-3386
Technical

COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE NPRDS: No

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT:

On Sunday May 15, 1994 at 1207 hours Nuclear Control Operators (NCO - RO licensed) commenced a reactor power reduction from 100% to 95% to remove the "A" Reactor Feed Pump (RFP) from service for planned maintenance to repair a bearing temperature problem. At 1300 hours the "A" RFP was secured from feeding the reactor vessel and at 1315 operators began a power increase to 100% of rated using the reactor recirc pumps. At 1317, and 1318 respectively, the new Digital Feedwater Control System (DFCS) automatically transferred the remaining "B" & "C" RFP's speed control from auto to manual. Reactor water level began to decrease due to the feedpumps being in manual and the increase in power from recirc pump speed increases. At 1322 the NCO received a Level 4 alarm (+30 inches) and an invalid intermediate runback occurred on the "A" reactor recirculation pump. The control operator attempted to restore reactor level by manual operation of the "B" and "C" feedpumps. Due to the non

linear response of the newly installed DFCS, operators could not mitigate the level transient resulting in a low reactor level scram at 1325. The root causes of this event were attributed to design deficiencies associated with enhancements made to the DFCS and inadequate training for manual operation of the new control system. Corrective actions included design changes to correct problems noted in the DFCS and additional simulator training with the feedwater controls.

END OF ABSTRACT

PLANT AND SYSTEM IDENTIFICATION

General Electric - Boiling Water Reactor (BWR/4)
Reactor Recirculation System (BB), Feedwater Control System (ZZ)
Feedwater System (AE)

IDENTIFICATION OF OCCURRENCE

TITLE: Engineered Safety Feature Actuation - Reactor scram on low level due to design and training deficiencies.
Event Date: 5/15/94
Event Time: 1325
This LER was initiated by Incident Report No. 94-099
CONDITIONS PRIOR TO OCCURRENCE

Plant in OPERATIONAL CONDITION 1 (Power Operation)
Reactor Power 96%, 1080 MWe.

DESCRIPTION OF OCCURRENCE

On Sunday May 15, 1994 at 1207 hours Nuclear Control Operators (NCO - RO licensed) commenced a reactor power reduction from 100% to 95% to remove the "A" Reactor Feed Pump (RFP) from service for planned maintenance to repair a bearing temperature problem. At 1300 hours the "A" RFP was secured from feeding the reactor vessel (pump was idling on min flow) and a reactor power increase commenced at 1315 at a rate of 1% per minute using the reactor recirc pumps. At 1317 and 1318 respectively, the new Digital Feedwater Control System (DFCS) automatically transferred the remaining "B" & "C" RFP's speed control from auto to manual. Reactor water level began to decrease due to the feedpumps being in manual and the increase in power from recirc pump speed increases. Over the next four minutes reactor level slowly decreased from +35 inches, and at 1322, the NCO received a Level 4 alarm (+30 inches). When level 4 was reached an invalid intermediate runback occurred on the "A" reactor recirculation

(recirc) pump. The control operator attempted to restore reactor level by manual operation of the "B" and "C" feedpumps from the speed controller Panel Display Station (PDS). The initial operator action was to reduce feedflow as reactor water level increased to +53 inches due to the recirc pump runback. A large decrease in feedflow was required to prevent reaching Level 8 (+54 inches) which trips the feedpump turbines and main turbine. This large reduction in feedflow resulted in a reactor level decrease to approximately +15 inches. The second control room operator reduced "B" recirculation pump flow during the reactor level decrease in an attempt to reduce steamflow/feedflow mismatch. Feedflow was also reduced as reactor level was increasing to +45 inches. Reactor level again began decreasing while operators attempted to manually adjust feedpump speed. At 1325 the reactor automatically scrammed from 80% power on Level 3 (+12.5 inches). Operators inserted a manual scram and main turbine trip in accordance with the emergency operating

DESCRIPTION OF OCCURRENCE (con't)

procedures. Reactor water level had decreased to -9 inches following the scram and then increased to greater than +54 inches (Level 8) and tripped the RFPTs. All immediate operator actions following the scram were appropriate and all plant systems functioned normally.

ANALYSIS OF OCCURRENCE

The Hope Creek feedwater system consists of three independent trains each capable of delivering 50% of rated capacity. The reactor level control system can be operated in automatic or manual. In automatic, the control system receives inputs from steamflow, feedflow and reactor level and adjusts feedpump speed to maintain the selected reactor level. The reactor feedpumps have demonstrated their ability to achieve 50% of rated capacity and 100% power operation has been approved for two feedpump operation. The reactor recirculation system is designed to automatically runback and reduce reactor power in anticipation of a level transient. Conditions such as condensate or feedpump trips or loss of vacuum can generate a runback signal in an attempt to reduce power and steam flow to a level where the remaining operating equipment can maintain reactor level. The runback signals for a feedpump trip are conditional runbacks in that they are not initiated until reactor level reaches level 4 (30 inches).

On April 27, 1994 Hope Creek Generating Station concluded its fifth refueling outage during which a new DFCS was installed. This change was being implemented due to previous reactor level scram events which were

attributed to failures associated with the original reactor level control system. The new system contained features which could prevent invalid signals from initiating level excursions and provide bumpless transfers when swapping modes of operation. one such change was to shift a RFP to manual upon a sensed failure of its discharge flow transmitter. The design concept for RFP Minimum Flow protection was to provide automatic action from the DFCS and to provide operator awareness that pump protection was being jeopardized. A pump transfer from auto to manual would be generated whenever the pumps discharge flow transmitter indicated a downscale or upscale condition. At normal full power operation, the discharge flow transmitters measure 11,100 GPM for each feedpump for a total of 33,300 GPM. Each flow transmitter is scaled for 0 to 16,200 GPM. This scaling was chosen, during initial plant design, on the basis that all three feedpumps would be in operation at full power and the 16,200 GPM would not be exceeded. With two feedpump operation near 96% power, the discharge flow transmitters exceeded the 16,200 GPM flow which was interpreted by DFCS as a transmitter failure.

ANALYSIS OF OCCURRENCE (con't)

On the afternoon of May 15, operators reduced the speed of "A" RFP and placed it on recirculation, to investigate a bearing temperature problem. Operators increased the "B" and "C" pump outputs to values high in the calibrated range of their transmitters to support near-full power operation. This combined with normal flow "noise" caused both pumps failure detection circuits to sense an out-of-range condition, causing both pumps to swap to manual control.

The "B" and "C" RFPs transferred to manual control without the operators being aware of it as the alarm for this condition was routed to a general system trouble overhead annunciator that was receiving numerous nuisance inputs. Overhead alarm window (B3-F1) "DFCS ALARM/TRBL" came in at 1242 and operators acknowledged it. This alarm came in repeatedly between 1242 and 1304, and was acknowledged each time. Operators attributed the alarm to expected high and high-high RFP flow nuisance alarms and silenced it. A review of the alarm chronolog following the event revealed that one of the inputs to the window, during the 22 minutes, was due to the feedpump shift to manual. The frequency with which this window annunciated after 1300 made it difficult for the operator to continue to investigate each alarm occurrence and perform his other duties.

The reactor operator who responded to the level 4 alarm took appropriate action to mitigate the event. The attempt to reduce feedpump flow was

appropriate and timely. The operator was monitoring level and feedflow/steamflow mismatch while attempting to adjust the feedpump and restore level to 35 inches. The response of the new DFCS controller was unlike that of the old feedpump speed control in that the old system had a linear response when increase or decrease commands were input. The new systems non-linear response is unlike any of the controls the operators typically use in day to day operations. Simulator training provided prior to installation of the plant controls did not identify the differences in response of the new controllers versus the old controllers. The identical hardware is installed at the simulator with the pushbuttons providing a non linear response; however, changes to the computer are required to better model actual plant response. This was a previously identified deficiency which was to be rectified following DFCS final tuning with changes to the simulator.

During the forced outage following this event, simulations were performed on the entire RFP trip and Level-4 functions. A simulation was finally able to locate the source of the invalid recirc runback problem. The design concept for these interface signals was to provide a field bus module (FBM) to recirc for feedpump status and two FBM output contacts for level 4 status. The FBM is a digital input/output module using solid state output contacts. This feature

ANALYSIS OF OCCURRENCE (con't)

was included so that a failure of a single level channel would not result in an invalid recirc runback. The DFCS would measure the feedpump reset logic and if any pump was tripped, then the (FBM) would provide a hardware open contact signal to arm the runback logic. The design also provided two FBM's for measuring reactor level as the other half of he
recirc runback logic. An FBM requires at least a 2 volt potential across the output to close. An open FBM in parallel with a FBM that is already closed will not have sufficient voltage available, across the output, to cycle itself closed. As a result, one out of two required FBM's was already in the tripped (open) condition. Tripping the second signal initiated a race condition. This race existed between the runback relay dropping out and the FBM, which still had a "no trip" signal closing.

SAFETY SIGNIFICANCE

This incident posed minimal safety significance as all systems functioned as required.

PREVIOUS OCCURRENCES

The root causes of this event were related to the installation and enhancements made to the newly installed digital feedwater control system. No similar types of events have been reported.

APPARENT CAUSE OF OCCURRENCE

The following causal factors combined for the reactor level control transient that precipitated an unplanned automatic reactor scram on May 15, 1994:

1. Design deficiencies which included:

a. An unnecessary pump protection feature intentionally added by the DFCS caused RFPs "B" and "C" to transfer from automatic to manual control when flow signals were sensed to be at 102% of calibrated range. Annunciation of this condition, which causes a control transfer from auto to manual, was routed to a general system trouble alarm rather than an existing overhead annunciator which alarms for feedpump auto transfer to manual.

b. A design deficiency incorporated in the recirc pump runback logic which initiated an invalid runback.

APPARENT CAUSE OF OCCURRENCE (con't)

2. Control room personnel did not initiate corrective action for an alarmed condition because repeated nuisance alarms were being input to the general system trouble alarm from the digital feed control system.

3. The invalid intermediate runback of reactor recirculation pump "A" increased the severity of the level perturbations, combined with inadequate training on the non linear response of the new feedpump controls, hindered the operators ability to mitigate the level transient.

CORRECTIVE ACTIONS

1. The following design deficiencies have been corrected:

The auto swap from auto to manual pump control for detection of the RFP flow transmitter failure has been deleted.

The alarm conditions, which created the majority of nuisance alarms during this event, were determined to be unnecessary and have been deleted.

The recirc pump runback logic deficiency has been corrected.

All transfers from auto to manual control now annunciate to a dedicated overhead alarm window describing the action.

2. Operations personnel have been directed to review and comply with station procedures for coping with nuisance alarms.

3. Additional simulator training has been conducted with all control room personnel in regard to the non linear response of the new digital control system. Training was conducted prior to startup and will be part of continuing training.

Sincerely,

R. J. Hovey
General Manager -
Hope Creek Operations

LLA/
SORC Mtg. 94-042

ATTACHMENT TO 9406210369 PAGE 1 OF 1

PSE&G

Public Service Electric and Gas Company P.O. Box 236 Hancocks Bridge, New Jersey 08038

Hope Creek Generating Station

June 14, 1994

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Dear Sir:

HOPE CREEK GENERATING STATION
DOCKET NO. 50-354

UNIT NO. 1
LICENSEE EVENT REPORT 94-007-00

This Licensee Event Report is being submitted pursuant to the requirements of 10CFR 50.73(a)(2)(iv)

Sincerely,

R. J. Hovey
General Manager -
Hope Creek Operations

LLA/

Attachment
SORC Mtg. 94-042
C Distribution

The Energy People

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